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16. Abstract

Many types of transportation systems, for example, public transit and commercial freight hauling and package delivery, may be categorized as being fleet operations. The environmental impacts of fleet operations such as these are affected by factors including the initial choice and selection of vehicles (types) comprising the fleet, vehicle age and maintenance, and the modal conditions under which the vehicles are operated including. And, the environmental impacts are even more significant when examined on a life-cycle basis. When examined on this basis, it is clear that "cleaner" fuels, alone, do not provide an environmental panacea or eliminate all of the environmental impacts of transportation. Moreover, many of the life-cycle impacts can be directly or indirectly attributed to vehicle operation. Controllable life-cycle impacts may also be affected by vehicle routing and scheduling decisions, in particular, in the case of a heterogeneous fleet. And, these other controllable environmental impacts of transportation systems and operation must also be considered if the overall impacts are truly to be minimized.

There has been little prior work that has considered environmental impacts in fleet vehicle routing and scheduling optimization, in particular, where the impacts were assessed systematically utilizing life-cycle impact assessment (LCIA) methodologies such as those described by SETAC (1993, 1991) and in current ISO standards (ISO 14040). In this report, we present a methodology and algorithm for the joint optimization of cost, service, and life-cycle environmental consequences in vehicle routing and scheduling, which we develop for a demand-responsive (paratransit or "dial-a-ride") transit system. Importantly, as a prerequisite to accomplishing this, we develop a decision-theoretic-based model for combining the results of multiple, current LCIA methods, as suggested by Bare, et al. (2000). And, we use the results of this model as the basis for specifying necessary weighting constants in the vehicle routing and scheduling objective function. We demonstrate through simulation that, as a result of our methodology, it is possible to reduce environmental impacts substantially (up to 25 percent or more) while increasing operating costs only slightly (about two to four percent). These results are predicated upon situational factors such as fleet composition, system loading, and vehicle-specific costs and environmental parameters. We felt the need to produce a large amount of empirical data in preparation to prove our concept. We feel that the results presented in this report are adequate to demonstrate the potential benefits of the methodology.

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